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XI.—*Notes on the Zambesi and the Shiré.* By the late MR. RICHARD THORNTON. (Addressed to SIR R. I. MURCHISON, Pres. R.G.S.)

*Read, November 9, 1863.*

Shupanga, January 7, 1863.

MY DEAR SIR RODERICK,—I last wrote to you from this place on July 14th last, on the *Pioneer* leaving here for Johanna: during the three months after that I worked away at my map of the Kilimanjaro, &c., interrupted twice for a week together, and several times for a few days, by sickness and the arrival and departure of friends, &c. The Ugono range and contour lines cost me much trouble and time in drawing, correcting, and redrawing over and over again: the latter are carefully drawn from my sketches, observations, and recollections, and although they cannot be accurate, they will give a much better idea of the shape of the mountains than shading would do. It was not until the 3rd of November that all—map, copy, and calculations, &c.—was finished and despatched *via* Quillimane to the Baron von der Decken at Zanzibar.

On November 7th I left Shupanga for Senna, staying a day on the way at Shamvara. From Senna I wished to go on to Yorongozo and Manika (to the south and south-west); but owing to the great famine which this year reigns throughout the country, no provisions could be procured on the way. I, however, succeeded in buying a month's supply of Quillimane rice and started up the river to examine the country lying to the north of the Zambesi and west of the Shiré; but owing to the disturbed state of the country (the followers of three rebel half-castes plundering in different directions), and the drought and famine obliging me to carry both water and provisions, I could not persuade my men to follow me far. I was, however, favoured with very clear weather, so that I got many good rounds of theodolite angles for a map, and three good views over the Shiré valley from mountains on its western side. I then went on to Lupata and spent there four days in examining the geology and taking theodolite angles and sketches, &c. My provisions being then nearly finished, I made all speed to Teté, which I reached on December 17th. The rains commenced with me on December 4th, with heavy storms; from that time till my arrival at Teté I had few dry days or nights. I have never felt the heat so great as during November and part of December last.

At Teté the famine was very severe; the natives were mostly dispersed in the woods far away seeking for wild roots and fruits, leaving only a few behind to look after the young crops. On November 16th, after an excessively hot day, a great hurricane,

accompanied with hail, broke over Teté, and in a few minutes unroofed about half the European houses in the town and sadly damaged the few shady trees: some of the hailstones were as large as pigeons' eggs. Excepting the results of the storm, the town was much improved since I last saw it, the Governor having employed the prison labour in making streets and cleaning the place. I remained there over Christmas Day, receiving every kindness from the Governor and my old friends.

I left on the 27th with three weeks' provisions, intending to finish my examination of the country to the north of the Zambesi; but in Lupata a number of sores broke out on my feet and ankles, which, aggravated by two days' rough walking, became so bad that I thought it best to go on with all speed to Shupanga, having heard of Dr. Livingstone's return there. I arrived here in safety on the evening of January 2nd, and have since been unwell, but am now getting all right again, excepting the sores on my ankles. I hope to leave here shortly to examine the Morambala and neighbouring hills, then up the Shiré to the lakes, doing and seeing as much as I can on the way.

The most important geological point I have observed on this journey is the much greater importance of what I have before called the "coast tertiaries" in the structure of the country, than I formerly considered them to have. They are found on the south bank of the Zambesi from Shupanga to Lupata, and on the north bank from Senna to Lupata. Here they consist chiefly of soft white sandstones, gravels and much conglomerate: above Senna the prevailing colour is reddish; the stratification is horizontal, forming nearly level plains and a low, long flat-topped plateau, and hills. On the north bank of the Zambesi from opposite Senna to half way to Lupata, they are metamorphosed and mixed with much greenstone and some volcanic rocks. The strike is about parallel to the river and the dip about  $15^{\circ}$  towards the south-west. To the north of Senna they are succeeded, at a few miles from the river, by the semi-metamorphosed Teté sandstone formation, striking about north-west and south-east and dipping at a high angle to the north-east, forming a range of mountains bounding the Shiré valley: a mass of porphyry and greenstone here separates the two formations. Farther up the Zambesi, a few miles inland, the semi-metamorphosed Teté sandstone formation again appears, but with a very different strike and dip, viz., strike about N.N.E. and S.S.W., and dip at a very high angle to the E.S.E. (in no other part have I seen this sandstone formation with so great a dip). Still farther up the river, a few miles inland, the old gneissic formation is found, the strike of the lamination being about north-west and south-east, and the dip at a high angle to the north-east; but the strike of the bedding appeared to be more nearly north and south, and the dip

west at about  $60^{\circ}$ . I here found fragments of coal in the bed of a river flowing from the mountains which form the western boundary of the Shiré valley.

The pass of Lupata is a valley of elevation through nearly horizontal strata of the coast tertiary formation; the dip of the whole is very slightly to the south-east. At the western entrance are sandstones, conglomerates, &c., capped by a great thickness of lavas; both are partially metamorphosed, so that the bedding of the lavas is very indistinct and joints are strongly developed. In the centre of Lupata both these rocks are much metamorphosed into various porphyries, &c., and in the mountains to the north and south of the pass the sandstones, &c., appear to overlie the lavas in great thickness. I found one fossil—a water-worn lump of coral—in the sandstone near the western mouth of the pass: it is the only fossil I have found in this formation in the Zambesi region.

From the rock specimens brought, and the description given me by Dr. Kirk, of the Rovuma River, I believe the coast tertiaries extend a considerable distance up that stream. The only fossils he found were specimens of fossil wood: he has one beautiful specimen of silicified wood, with the bark still remaining. Beyond the tertiaries the Teté sandstone and coal formation probably follow, as they found some fragments of coal in the bed of the river.

In my next letter I hope to give you something of the main structure of the country, which is, I think, now coming out very simply, but slowly, owing to the greatness and the difficulty of exploring in any particular direction.

I have decided to return to England this year, if possible, so that there is little or no chance of my crossing or reaching the main axis of the structure, and probably I shall also have to give up my long-intended exploration of Manica and other districts.

RICHARD THORNTON.

[Between the date of the foregoing letter and his untimely death, Thornton had few further opportunities of adding to the store of geological and geographical information accumulated in his journals. He left Shupanga on the 17th of January, in his own boat, expecting to overtake Dr. Livingstone and the rest of the expedition who were attempting to ascend the Shiré in the two steamers, the *Pioneer* and the *Lady Nyassa*. It was his intention to ascend this river and explore, as far as practicable, Lake Nyassa, hoping to do this and reach Zanzibar on his road to England by July or August. His journal records a wet and stormy voyage up the Shiré, during which he had many sleepless nights and in the daytime suffered much from the stifling heat which prevailed in the intervals between the storms. He overtook the steamers on the 28th of January

near the "Elephant Marsh" on the Shiré, and accompanied them in their slow progress amongst the shoals of that much-obstructed river until February 13th, when he started alone for the Mission Station. Arrived there he found the whole district suffering from famine, and a journey overland to Teté to purchase cattle being proposed, Mr. Thornton volunteered to undertake it in company with the Rev. Mr. Rowley. The privations and exposure to which he was subjected in the toilsome walk over the country to Teté and back, encumbered with the charge of more than 100 head of sheep and goats, seem to have tried much a constitution already weakened by previous over-exertion. He returned to the Mission Station from his successful trip on the 2nd of April. On the 11th, having rejoined Dr. Livingstone on board the *Pioneer*, he was taken ill with dysentery and fever, and on the 21st he died. The Rev. Mr. Rowley, on receiving notice of the critical state of his friend and late companion, hastened to the place where the steamers lay, hoping to find him still alive; but "death," as he records the event in his journal, "was beforehand with me—when I arrived I found all hands assembled around his grave." A copy of Mr. Thornton's Journals, made by his sisters, has been presented to the Society, and will be bound and preserved in the Library. It forms eleven large volumes of MS., and includes, as mentioned by the President in his last anniversary address, "the details of upwards of 7000 observations made to fix geographical points and to determine altitudes" in the Zambesi region. The Journals also contain an immense amount of geological and mineralogical data, the correlation of which will be perhaps an almost impossible task in the absence of their gifted author.—ED.]

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XII.—*On a few Fossil Bones from the Alluvial Strata of the Zambesi Delta.* By JOHN KIRK, ESQ., M.D., F.R.G.S.

*Read, April 25, 1864.*

THE following notes relate to a collection of fossil remains found in the bed of a stream which joins the Zambesi 40 miles from the present coast-line, near the head of the delta, and which carries off, during the rains, the surface-water from the plain to the coast.

The fossils occurred loose, mingled with quartz pebbles, and nodules of indurated ferruginous clay, polished and blackened. They had been transported by the rush of water from a little way inland, and were more or less rounded, but perfectly formed whenever the matrix adhered. This resembled the soil of the delta; being a clay mixed with sand, and impregnated with titaniferous iron.